

Survey on the Use of Green Concepts in Building the Green Library in Beitou: An analysis of the Taipei Public Library Beitou Branch

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Abstract

Since the Executive Yuan in Taiwan established the Council for Sustainable Development in 1996, green building policies have become the focal point of domestic construction industries in pursuing sustainable development. The Architecture and Building Research Institute, Ministry of the Interior, Taiwan also began promoting the green building labeling system in 1999 and pioneered the demonstration of the concept by using public buildings to facilitate the comprehensive development of green buildings. Presently, private buildings are not strictly regulated; a mechanism for the use, management, and maintenance of public green buildings. Based on the analysis of the Taipei Public Library Beitou Branch, a mechanism for the use, management, and maintenance of public green building is proposed in this paper.

Keywords: Green building; Green building label; Public building; Management; Maintenance

Introduction

The mentality of sustainable development in the 21st century is based on the motto of Think globally; act locally [1] and green buildings are the mainstream development. Green buildings are respectively referred to as eco-architecture, green buildings, and environmental symbiosis buildings in Europe, the United States and Canada, and Japan because of the distinct backgrounds of these countries. However, green buildings fulfill the common purposes of saving energy, using resources efficiently, reducing environmental loads, increasing natural environmental exposure, and ensuring global sustainable development. Green building labeling is a crucial green building policy implemented by the governmental departments in Taiwan [2]. Taiwan is located in a subtropical region with pleasant climates year-round; the climate is characterized by ample sunshine and humid summers. In addition, geographical factors cause energy supply and water resources to become a serious challenge in the Taiwan living environment. Rigorous planning is required to distribute resources. In their daily lives, 80-90% of the population remains indoors, either in offices, schools, or homes; therefore, the improvement of building design has become a crucial task for the construction industry. Ecological, energy-saving, waste-reducing, and health-promoting buildings are collectively called green buildings [2] and are prioritized by public construction organizations. According to statistics, a total of 1,677 green building labels and 3,794 Green Building Candidate Certificates were conferred from September 1999, when case reviews began, to November 30, 2015. In addition, attention must be paid to post occupancy management and maintenance to achieve energy reduction in public green buildings and the effects of establishing green building assessment systems. Regarding relevant implementations, the current green building assessment indicators must be modified to conform to policy directives. Because of the increasing public green building trend, the sustainable use, management, and maintenance of these buildings are crucial. This study investigated the use, management, and maintenance of green buildings and whether they conform to the management and maintenance regulations established through the green building labeling system. The post occupancy management and maintenance of the Taipei Public Library Beitou Branch [3] (hereafter Beitou library) (Appendix A) was studied using empirical methods [4] to determine the administrators' and users' level of understanding of the green

library and whether the process of post occupancy management and maintenance could be improved.

Literature Review

The process of green building development was reviewed using previous green building studies and management and maintenance theories. These relevant studies were subsequently analyzed to establish the theoretical basis of the research framework.

Implications of green buildings

Because of the second oil crisis in the 1970s, the 1992 Earth Summit further elevated global environmental consciousness and multiple agreements were protocolled, including the Framework Convention on Climate Change, Agenda 21 [5], the Convention on Biological Diversity [6], Forest Principles, and the Rio Declaration on Environment and Development. The Habitat II conference was held in June 1996 in Istanbul in response to urban crisis occurring at the time; Sustainable Building 2000 was held in October 2000 in Maastricht, Netherlands, in which more than one hundred theses and two hundred study reports from the delegations of 35 nations were presented; green building environmental planning is one of the priority concerns for advanced countries worldwide.

Through domestic promotion by the Architecture and Building Research Institute, Ministry of the Interior, Taiwan, the Green Building and Living Environmental Technology Plan was proposed to promote research and development of the active prevention of pollution, the reduction of energy consumption, and the recycling of resources in buildings. One of the goals was to establish a set of building

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Received December 22, 2015; Accepted January 19, 2016; Published January 28, 2016

Citation: Liao YT, Chern SG (2016) Survey on the Use of Green Concepts in Building the Green Library in Beitou: An analysis of the Taipei Public Library Beitou Branch. J Tourism Hospit 5: 192. doi:10.4172/2167-0269.1000192

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environmental performance assessment regulations and systems for assessing the environmental performance of building designs and construction projects. In conjunction with subsequent green building counseling management strategies, individual regulations, incentives, laws, and policies were formulated to alleviate the effect of construction on the environment and thereby implement environmental symbiosis and ensure long-term global sustainable development.

Promoting public green buildings

The promotion of public green buildings in Taiwan can be divided into the five stages of emergence, organization, research and development (R&D), promotion, and development.

Stage 1: Emergence (Building energy conservation), 1980-1995: Green building development in Taiwan emerged in response to the energy crisis. During the initial period of the energy crisis, funds were provided to the Energy and Resources Laboratories of the Industrial Technology Research Institute for undertaking energy conservation investigations. The envelope-load (ENVLOAD) and performance of air-conditioning systems (PACS) indices were established as design indices for building envelopes and efficient air-conditioning systems in Taiwan. In addition to completing these investigations during this stage, legislation related to building energy conservation regulations were completed in 1995.

Stage 2: Organization (Launch), 1992-1997: In response to the increase in global environmental consciousness and the promotion of sustainable development, the Executive Yuan, Taiwan established the Working Committee on National Environmental Change Policy in May 1992 to integrate domestic resources and seek a unification of power. The Global Change Research Center was established in August 1992 at National Taiwan University. In August 1997, the Executive Yuan established the National Council for Sustainable Development in which constructing green buildings was listed as the focal task of the Urban and Rural Development Working Group.

R&D, 1996-1999: This stage involved the official development of green buildings in Taiwan, and includes four major periods: current status survey analyses, assessment indicator studies, policy instrument formulations, and application integration and review were conducted in 1998, 1999, 2000, and 2001, respectively. In May 1999, to effectively promote the development of green buildings, the Architecture and Building Research Institute, Ministry of the Interior, Taiwan formulated the Seven Major Green Building Assessment Indicators, which address building site greenification, water conservation, water resources, daily energy savings, CO₂ emissions reduction, construction waste reduction, and sewage and garbage disposal improvements.

Promotion, 1991-2000: Green buildings are promoted to alleviate environmental degradation, the greenhouse effect, and global warming and have become a major construction trend worldwide, including in Taiwan. In 2001, the Executive Yuan approved the Green Building Promotion Program, which promotes using the least amount of resources and producing minimal waste, to fulfill the goals of environmental symbiosis and prosperity and global sustainable development.

Development, 2000: The active promotion of green buildings by the Architecture and Building Research Institute produced favorable outcomes. However, the green building concept is currently stagnated in the recognition phase. The goal in this stage is to physically implement green building development.

An Empirical Investigation on the Use, Management, and Maintenance of the Beitou Library

The investigation period spanned 3 months from June to August 2010. The investigations were conducted through onsite interviews and surveys with readers in outdoor activity areas during weekend holidays.

Respondent demographics

The demographic data of the respondents in this study comprised sex, age, educational level, and occupation. The survey data are compiled as follows.

Sex: Among the 412 respondent questionnaires, 132 men and 280 women respectively accounted for 32.1% and 67.9% of the respondents. All the participants were above 13 years of age. According to this data, the number of female readers at the Beitou library was approximately double the number of male readers (Figure 1).

Age: Among the 412 questionnaires, the majority of the respondents were aged 35-44, comprising 125 people and accounting for 30.3% of the respondents, followed by respondents aged 25-34 (82, 20.0%), 13-17 (79, 19.2%), 18-24 (58, 14.1%), 44-54 (53, 12.7%), 55-64 (12, 3.0%), 65-74 (2, 0.49%), and >75 (1, 0.24%) (Figure 2).

Education level: Among the 412 respondent questionnaires, the readers who visited the Beitou library were characterized by the following education levels: university (132, 32.03%), primary school (11, 2.66%), middle school (31, 7.52%), (vocational) high school (121, 29.36%), junior college (94, 22.81%), master's degree (21, 5.10%), and PhD degree (2, 0.49%) (Figure 3).

Occupation: Among the 412 respondent questionnaires, the occupational distribution of the readers who visited the Beitou library were in the order of students (123, 29.85%), housewives (64, 15.53%), retired (45, 10.92%), service workers (42, 10.19%), teachers (31, 7.52%), self-employed (23, 5.58%), unemployed (21, 5.09%), private business staff (19, 4.61%), employed in other occupations (14, 3.39%), civil servants (13, 3.15%), labor workers (8, 1.94%), manufacturing workers (7, 1.69%), serving in the military (1, 0.24%), and agricultural, forestry, fishing, or husbandry workers (1, 0.24%) (Figure 4).

Statistical analysis of respondents' opinions on the use, management, and maintenance of the Beitou green library: The respondents' opinions on the use, management, and maintenance of the Beitou library were statistically analyzed and compiled in Figure 5.

(1) According to the percentage (%) and number distribution for each question item, except the "Do you understand the current post occupancy evaluation status of this building?" which scored 10.0%, the public respondents expressed their overall satisfaction with individual facilities of the Beitou library, giving an average score of 51.3%. Among the question items, the "Do you approve of Beitou library implementing environmental building materials and reducing CO₂ emissions?" item scored the highest rating of 78.4%.

(2) Question items that scored >70% for overall satisfaction were in the order of "Do you approve of Beitou library implementing environmental building materials and reducing CO₂ emissions?" (78.4%), "Do you approve of Beitou library applying minimally processed materials to facilities by using minimal paint and artificial colorants and applying environmentally friendly coatings?" (76.7%), "Do you approve of the overall application of recycled or completely recyclable construction materials and the reduction of unnecessary decorations in the Beitou library?" (74.7%), "Do you approve of Beitou

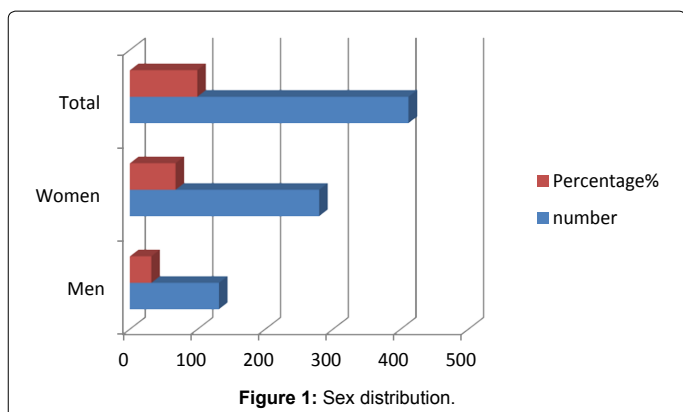


Figure 1: Sex distribution.

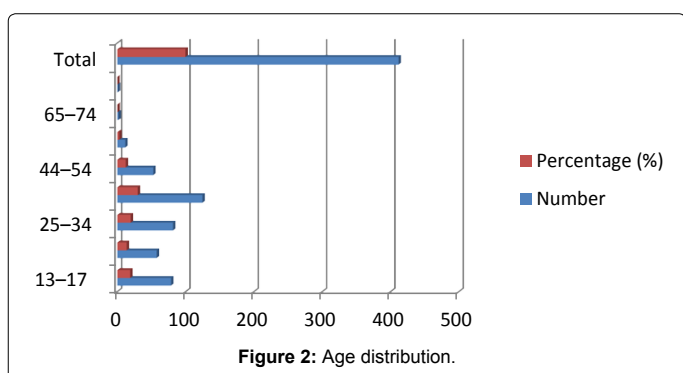


Figure 2: Age distribution.

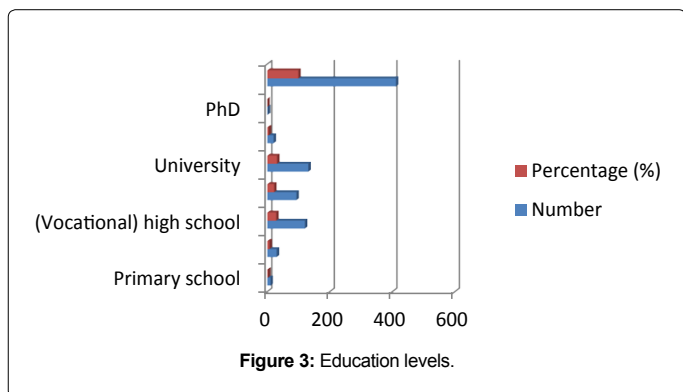


Figure 3: Education levels.

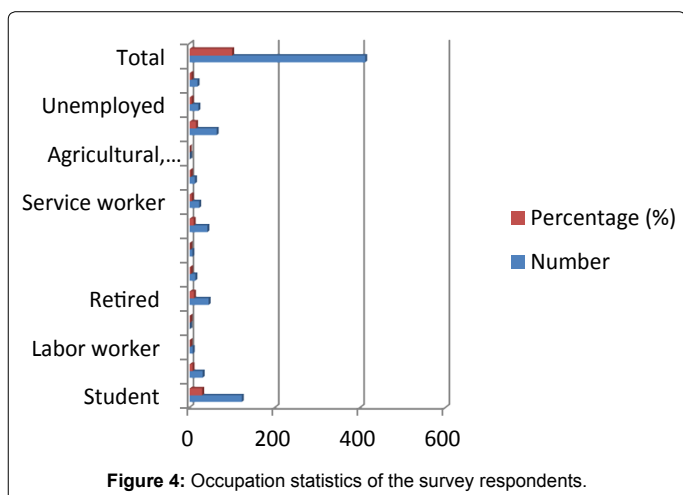


Figure 4: Occupation statistics of the survey respondents.

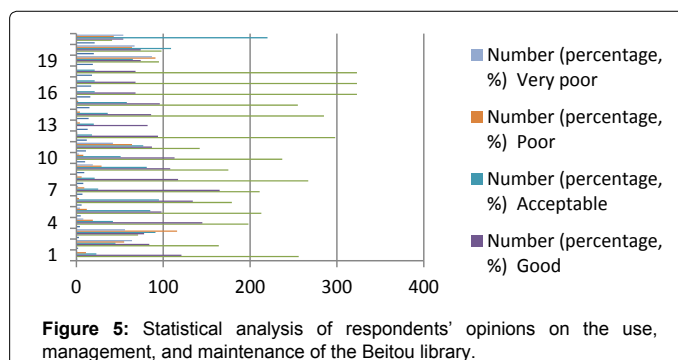


Figure 5: Statistical analysis of respondents' opinions on the use, management, and maintenance of the Beitou library.

library using solar power as a partial indoor power source?" (74.0%), and "Do you approve of the floor-to-ceiling window design at the Beitou library for providing natural lighting and ventilation, noise insulation, and energy conservation?" (72.3%).

(3) Question items that scored below 70% but above 60% were (presented in decreasing order): "Do you approve of Beitou library recycling rain water for flushing toilets inside the Beitou library?" (69.2%), "Do you understand the meaning of CO₂ emissions reduction indicators?" (64.8%), "Do you understand the meaning of green building labels?" (62.1%), and "Do you approve of the Beitou library adopting a lightweight ecological green roof with a gentle grass slope for absorbing CO₂ and reducing the environmental effect of acid rain?" (61.9%). Among a total of 21 items, nine items scored over 60% with an average score of 70.5%.

Empirical framework and survey plan

The investigation framework and survey plan must be established before conducting empirical investigations, which comprise observations and surveys, and subsequent empirical result analyses.

Establishing the empirical framework: The empirical framework was formulated based on the introduction and literature review sections of this paper, and involved surveying the current state of the Beitou library, compiling and analyzing data, and administering surveys. The respondents were the users and staff of the Beitou library. The empirical results were analyzed based on the library use, management, and maintenance survey results.

The current status of the library, problems associated with the library, issue formulation, a summary of relevant topics, and suggested countermeasures derived from the investigation process are described as follows:

(a) Current status of the library: This survey focused on the collection of basic data on the current status of the Beitou library. The current use, management, and maintenance status of the Beitou library were clearly determined through this survey, and the results provided a reference for identifying problems.

(b) Problem identification: An overall view of the use, management, and maintenance problems associated with the Beitou library was obtained by comprehensively analyzing the respondents' awareness of use, management, and maintenance.

(c) Issue formulation: To determine the causes of problems as well as the direction of and consensus on problem resolutions, the issues were formulated based on the use, management, and maintenance survey results.

(d) Topic summarization: By compiling the separate issues, topics

regarding the use, management, and maintenance faced by the Beitou library were summarized.

(e) Countermeasure suggestions: Countermeasures were suggested for addressing individual issues to improve the use, management, and maintenance of the Beitou library.

The empirical survey plan: This study empirically investigated the Beitou library. The survey plan was divided into investigation planning, questionnaire design, implementation, survey interviews, and result summarization. The investigation process was primarily divided into five stages: establishing the investigation purpose, establishing the survey content and initial question items, compiling data and designing the questionnaire, surveying and interviewing respondents, and analyzing the investigation results.

Designing the questionnaire

Based on the introduction and literature review sections on the investigation of relevant topics and empirical investigations on the use, management, and maintenance of the Beitou library, the questionnaire used in this study was designed.

Questionnaire content: The survey purpose was to understand how the library users currently used the Beitou library facilities and the management and maintenance of these facilities. The questionnaire was designed to determine the level of understanding of users and administrators regarding individual library facilities, the management and maintenance of these facilities, and the users and administrators' awareness of the green building label. The main issues addressed in the questionnaire comprised the users' understanding of the implications associated with the green building label, the management and maintenance of library facilities, post occupancy conditions, and the use of various facilities at the Beitou library.

The survey process: In this study, the building use, management, and maintenance situation was established and user satisfaction with the green library building was determined based on use, management, and maintenance and the green building label. The Beitou library was chosen as the research subject.

The questionnaire consisted of three components, which are described as follows:

(a) Investigation items: The investigation items comprised the current building use, management, and maintenance status; the conformability of the building to the green building label; and the use, management, and maintenance of the library.

(b) Investigation content: The first part was a general investigation of respondent demographics comprising sex, age, education level, and occupation. The second component was based on the post occupancy management and maintenance of the building. The third component, related to the users and administrators' awareness level of the green building label, comprised indicators of biodiversity, the indoor environment, daily energy saving, construction waste reduction, water resources, base greening, base water conservation, CO₂ emissions reduction, and sewage and garbage disposal improvements.

Status of current use

The Beitou library is located at No. 251, Guangming Road, Beitou District, Taipei, Taiwan, occupying an area of 8,907 m²; comprising a combination of steel, reinforced concrete, and wooden structures; standing two stories above ground level it has one basement level. The

base of the building is an urban open space with a building coverage ratio of 15%, a floor area ratio of 60%, and a total floor area of 5,382 m².

The current use, green building label, management, and maintenance of the Beitou library are described as follows:

Current use of the Beitou library: (a) First floor: The base floor of the Beitou library has a total area of 731.91 m² and contains an information and general service desk, a newspaper and periodical section, a reference section, computers for Internet searches, Chinese publications, green building publications, an outdoor reading area, an elevator, and washrooms.

(b) Second floor: The second floor of the Beitou library has a total area of 589.57 m² and contains book zones (Chinese, foreign, and special collections, such as ecological conservation publications), multifunctional discussion rooms, an outdoor reading area, the Director's office, an office area, an elevator, and washrooms.

(c) Basement: The Beitou library basement has a total area of 673.63 m² and consists of a children's room, an outdoor reading area, an audio-video room, a story-telling area, Chinese books, preschool children's books, foreign books, a reference section, a breastfeeding room, a control room, an elevator, and washrooms.

The management and maintenance of the Beitou library: The management unit must be aware of the warranty coverage and optimally manage and maintain individual equipment and systems according to their respective characteristics by planning individual maintenance and operating schedules and using material supports. Human power and materials must also be reasonably and effectively distributed to use the individual equipment and systems effectively and maintain efficient operation. Topics related to the management and maintenance of the library are separately described based on three categories as follows:

(a) Management and maintenance concepts related to the Beitou library: Public libraries not only educate the public, preserve cultures, distribute information, and provide recreational activities, but they also supply resources to the public for working, learning, and daily life. In addition, public libraries provide healthy, environmentally friendly, and comfortable reading spaces to the public, thereby contributing to the sustainable management of global ecologies. The successful development of the Beitou library as a green building must be used as a reference for the future development of green buildings belonging to subsequent branches of the Taipei Public Library. The management and maintenance concepts related to the Beitou library are separately described in the following subsections:

Promoting public understanding of the Beitou library green building label. Green building libraries not only improve the environment by creating a comfortable, elegant, and healthy reading environment through the fulfillment of the green building label requirements, but also increase the public's attraction to the facility by being entirely integrated with the surrounding environment. Users can enjoy reading library books while experiencing the energy provided by nature, thereby fulfilling their spiritual lives.

Promoting public understanding of the utility of the Beitou library green building. All readers must coordinate in a multitude of participatory activities and operations to achieve the conceptual goal of developing a green library building. The Beitou library serves as a core example of a living ecological park facility. The main operation of the library can link similar spaces of historical significance and revitalize the Beitou ecological culture through space building processes.

Increasing public (user) satisfaction with the use, management, and maintenance of individual facilities. This concept includes maintaining an ecological environment, promoting the symbiotic relationship between buildings and environments, sustainably managing living environments, and conserving building energy. These are worth promoting in the development of green public library buildings nationwide.

Increasing the satisfaction of professional workers with the use, management, and maintenance of the green Beitou library building. The facilities of the library buildings are considerably diverse, complex, and technical and rely on specialized professionals for management and maintenance. Each facility has its own operational life cycle. Establishing a satisfactory management and maintenance system not only elevates the building utility value and reduces the cost of maintaining and upgrading facilities, but also prevents and eliminates accidents and disasters. Management and maintenance of individual facilities are expected to become the most onerous tasks involved in building management and maintenance.

Increasing the implementation of administrative management and maintenance in the green Beitou library, and enhancing the public's (users) understanding regarding the maintenance of green buildings. The goal of management and maintenance is to maintain the proper functions of facilities and provide administrators and the public (users) with benefits through optimally functioning facilities. Developmental strategies for improving green spaces were formulated; the results can serve as a future reference for the development of systems for green buildings.

(b) Management and maintenance items related to the Beitou library: Management and maintenance inspections of the building sites and structural bodies. The structural bodies of buildings refer to the physical entities in an enclosed space. From a structural behavior perspective, physical entities can be identified as either structural or nonstructural bodies. Structural bodies include foundations, main columns, load-bearing walls, floors, and roofs and are responsible for the structural safety of the entire building; therefore, considerable attention must be paid to the safety of these structural components. Nonstructural bodies comprise outer and partition walls.

Management and maintenance of individual building facilities. Building facilities require the maintenance of building functions and properly functioning life-support systems. The main systems include electromechanical, appliance, and drainage systems. All engineering systems, including other electronic equipment and drainage systems, are periodically inspected and maintained by commissioned professionals.

Management and maintenance of fire safety equipment. According to Article 9 of the Fire Service Act (Taiwan), fire safety equipment must be installed in buildings and maintained annually by entrusted fire protection engineers and technicians. The related maintenance reports must be filed and sent to local fire departments before December 31.

According to the implementation details described in Article 6, fire safety equipment is periodically maintained using three inspection procedures: external, performance, and comprehensive inspections. The external appearances of fire safety equipment are inspected for possible damage and inappropriate configuration; fire safety equipment is tested for possible malfunctions; and the overall operation of the fire safety equipment is determined. External and performance inspections are performed biannually and comprehensive inspections are performed annually.

The management and maintenance of greenification through plantations. The management and maintenance of plantation greenification highly influences green buildings and are especially crucial to the Beitou library. The items considered in the management and maintenance of plantation greening comprise management and maintenance operations and schedules, human power distribution, and application extent of plantation greenification. Maintenance operations include pruning arrangements, lawn arrangements, soil basement mixtures, chemical applications, physical support structures, and plant irrigation; management and maintenance are scheduled monthly, excluding irrigation, which is separately scheduled according to the growth environment and conditions of the various plants; human power is periodically redistributed according to the management and maintenance units of the Beitou library; and the extent of application involves the surrounding plants and the transfer of tree species, which are emphasized during adaptive growth periods. When growth conditions stabilize, the plants are periodically managed and maintained in accordance with landscaping management and the maintenance zones surrounding the library.

Management and maintenance problems, issues, and topics related to the Beitou library. Problems regarding the current use of the library were addressed to review the use, management, and maintenance procedures further. Subsequently, issues were proposed and topics were summarized according to the interview content:

Problem 1: Library users require further education.

Problem 2: The library staff's awareness of green building use, management, and maintenance requires enhancement.

Problem 3: Education covering the use, management, and maintenance of individual facilities requires improvement.

Problem 4: The management of the library collection requires further improvement.

Problem 5: The management and maintenance manual requires further improvement.

Issue 1: Clarifying authoritative jurisdiction functions.

Issue 2: Establishing long-term repair key performance indicators.

Issue 3: Preserving building original documents.

Issue 4: Establishing use, management, and maintenance systems.

Topic 1: Level of users' understanding regarding green building labels.

Topic 2: Level of users' understanding regarding the post occupancy conditions of the green Beitou library building.

Topic 3: Level of users' awareness regarding the use of individual facilities at the green Beitou library building.

Topic 4: Level of users' awareness regarding the use, management, and maintenance of the Beitou library.

Topics on and Countermeasures Regarding the Use, Management, and Maintenance of the Beitou Library

Ecological buildings incorporate local environmental features and relevant natural factors (i.e., sunlight, air, and water streams) to increase the livability of buildings and reduce any unfavorable environmental factors. In addition, ecological buildings avoid destroying cycles of local environmental factors, which would interfere with the functioning

of local ecological systems. Resource and energy consumption and construction waste are minimized during the entire process of building design, construction, use, management, and demolition.

Building designs satisfying these conditions conform to the concept of ecological buildings.

Countermeasures regarding topics related to use

(1) According to the questionnaire results, users can gain a comprehensive understanding of the post occupancy conditions of the Beitou library through the establishment of a comprehensive database. In a database, all data on the facilities, maintenance records, factory information, and management are filed and tables or statistical reports for performing various troubleshooting and searching tasks are produced through data compilation, sorting, categorization, computation, and the use of statistical functions provided by a computer.

(2) The public's opinions mainly pertain to common rules and methods for managing and maintaining individual facilities. In addition to authorized management and maintenance requirements, a set of key performance indicators is required to facilitate related judgments. Other management and maintenance systems and items also require the establishment of basic performance requirements.

Countermeasures regarding topics related to management and maintenance

(1) Following the multi-storey and large-scale building development trend, building functions have become increasingly complex. Digitalization management must be applied to increase the effectiveness of buildings; assistance must be provided in operating, managing, and maintaining buildings to use the functions of buildings optimally through their effective life cycles. This is becoming an increasingly important topic for administrators and users.

(2) Increased comfort and user convenience in the functioning environment can be obtained by performing proper management and maintenance procedures. Thus, a well-established building management and maintenance system not only provides a comfortable and convenient functioning environment, but also the benefits of efficient management and cost control.

(3) The target of public building services includes the building staff and the greater public. Thus, public buildings are extremely meaningful because they create the government's impression of such buildings. Accordingly, the promotion and post occupancy management and maintenance of public green buildings must be considered as the priority for relevant government authorities.

(4) The focus of past management and maintenance procedures focused on the management of facilities (i.e., maintenance and repair of properties). However, increasing management and maintenance demands, and the increased diversity of public building use, management, and maintenance have rendered previous use, management, and maintenance models unable of satisfying the overall demands of public buildings. Thorough planning and rigorous post occupancy controls are required to optimize the value of buildings to ensure that, using the provided use, management, and maintenance strategies, facilities can be maintained under optimal conditions and used to achieve optimal benefits.

Conclusion

The collection of inspection data is crucial in the management and maintenance of facilities. The long-term use of facilities

can be evaluated by accumulating long-term management and maintenance records and formulating easily executable plans for various types of buildings based on specific post occupancy goals and restrictions. Through these data, increasingly accurate corrections, recommendations, and predictions can be made for managing and maintaining future buildings. Thus, energy can be further conserved and value related to the use, management, and maintenance of buildings can be enhanced. During the process of building operations and management, improper handovers can easily cause numerous managerial problems for new staff. Therefore, a set of comprehensive standard operating procedures must be formulated for the management and maintenance of individual facilities. This is accomplished by formulating precautions and operating standards for each specific procedure to provide administrators with a guideline for managing operations and the maintenance of facilities. Based on the investigation results of questionnaires, and the public respondents' opinions on the use of green building, staff can update management and maintenance data to files containing all data regarding the facilities, maintenance records, factory information, and management, and produce tables or statistical reports to perform troubleshooting and searches through data compilation, sorting, categorization, computation, and the use of statistical functions provided by a computer. Thus, a comprehensive database is established, facilitating future search operations.

Conflict of Interest

The authors declare that there are no conflicts of interest.

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